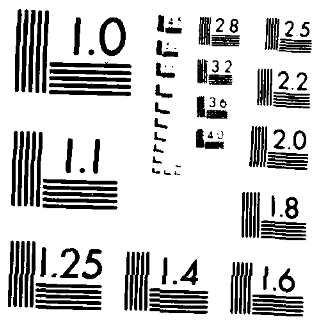
AD-A122 268 THE EFFECT OF WATER DISPLACING CORROSION PREVENTIVES ON 1/1
STRESS CORROSION.:(U) AERONAUTICAL RESEARCH LABS
MELBOURNE (AUSTRALIA) L WILSON ET AL. MAR 82
UNCLASSIFIED ARL/MAT-NOTE-132 F/G 11/6 NL

END
DATE
FILMED
1 83
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ARL-MAT-NOTE-132

AR-002-341

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

AERONAUTICAL RESEARCH LABORATORIES

MELBOURNE, VICTORIA

MATERIALS NOTE 132

THE EFFECT OF WATER DISPLACING CORROSION PREVENTIVES ON STRESS CORROSION CRACKING OF ALUMINIUM ALLOY 7075-T651

by

L. WILSON

and

R. S. G. DEVEREUX

APPROVED FOR PUBLIC RELEASE

COPY No

MARCH, 1982

AR-002-341

DEPARTMENT OF DEFENCE
DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION
AERONAUTICAL RESEARCH LABORATORIES

MATERIALS NOTE 132

THE EFFECT OF WATER DISPLACING CORROSION PREVENTIVES ON STRESS CORROSION CRACKING OF ALUMINIUM ALLOY 7075–T651

by

L. WILSON

and

R. S. G. DEVEREUX

SUMMARY

The effectiveness of some commercial water-displacing corrosion-preventive formulations with respect to the inhibition of stress-corrosion cracking of 7075-T651 aluminium alloy has been investigated. The formulations consisted of examples of three types of protective agents, viz. oily films, soft (grease-like) films, and hard (resin-like) films. All three types of formulation used were effective in reducing rates of stress-corrosion crack growth in laboratory tests.

POSTAL ADDRESS: Chief Superintendent, Aeronautical Research Laboratories, Box 4331, P.O., Melbourne, Victoria, 3001, Australia.

CONTENTS

	Page No
1. INTRODUCTION	1
2. EXPERIMENTAL	1
3. RESULTS	2
4. CONCLUSIONS	2
REFERENCES	
FIGURE	
DISTRIBUTION	
DOCUMENT CONTROL DATA	

1. INTRODUCTION

Water-displacing corrosion-preventive (WDCP) formulations are being used by aircraft operators to protect aircraft structures from deterioration by corrosion. Earlier work by Lewis and Hinton (1) at ARL assessed the effectiveness of three of these formulations— LPS3, PX112 and WD40—in controlling: (i) corrosion of mild steel specimens exposed to (a) an outdoor industrial environment, and (b) an operational aircraft environment, and (ii) the rate of propagation of stress-corrosion cracks in aluminium alloy 7075–T651, double cantilever beam (DCB) specimens exposed to an operational aircraft environment. They concluded that the film produced by a single application of the WDCP "is of limited protective value on steel" and "has no significant effect on the rate of growth of stress-corrosion cracks in 7075–T651 aluminium alloy". Since their work was reported, many new WDCP formulations have been approved as meeting the requirements of various national military specifications. Approved formulations include

(1) Ardrox 3961; DEF. STAN. 68/10—PX24.

(2) Preservac Wetproof; DEF. AUST. 1002—PX112.

(3) Amlguard; MIL-C-85054 (AS)

(4) Boeshield T9; BMS-3-23.

(5) Tectyl 472 B; MIL-C-23411 A (YD) Type 2.

(6) WD40; DEF. STAN. 68/10—PX24.

None of the above-mentioned specifications prescribes tests for assessing the effectiveness of WDCP formulations in controlling stress-corrosion cracking in aluminium alloys.

This report describes work carried out to determine the effect of periodic applications of each of these six WDCP formulations on the growth of stress-corrosion cracks in a laboratory test programme where 7075-T651 aluminium alloy DCB specimens were periodically immersed in 3·5% sodium chloride solution.

Another report (2) will describe experiments testing the relative effectiveness of these WDCP formulations in controlling surface corrosion and exfoliation corrosion of aluminium alloys.

2. EXPERIMENTAL

Seven DCB specimens, one to test each of the WDCP formulations plus one for a control specimen, were manufactured from 7075-T651 aluminium alloy plate. The specimen size and method of testing is given in Reference 3.

After the lengths and opening displacements of cracks introduced into them were measured, each specimen was immersed in a separate solution of 3·5% sodium chloride for 30 seconds. The specimens were then allowed to stand in the laboratory air for 24 hours, after which the lengths of the cracks were again measured. Immersion of the specimens in their respective solutions for 30 seconds was then repeated and the crack lengths again measured after another 24 hours in the laboratory air. This sequence was continued for 72 hours by which time stress-corrosion cracks were obviously growing in each specimen. At this stage, the test procedure was varied for six of the specimens. After removal from the salt solution each of the six was immersed in a particular WDCP formulation for 30 seconds before being left in the laboratory air. This procedure was repeated on most working days for a total of 90 days to assess the effect of the WDCP formulations on the crack growth rate and to compare the rates with that in the control specimen.

The routine was chosen to simulate (crudely) an aircraft with a stress-corrosion crack flying in a marine atmosphere and being treated with a WDCP after each flight.

3. RESULTS

Figure 1 shows the increase in crack length with time for the specimen treated with 3·5% sodium chloride solution and for the six specimens treated with both sodium chloride solution and a WDCP. All of the WDCP formulations investigated significantly decreased the rate of growth of the stress-corrosion cracks compared to that in the control specimen. Treatment with Amlguard, Boesheld T9, Ardrox 3961, Tectyl 472 B and WD40 produced cessation of stress-corrosion cracking within 24 hours after application, while the PX112 treated specimen took 8–10 days to exhibit the full effect. In all cases the crack length/time curves showed alternate periods of crack growth and crack growth inhibition. It is postulated that the sudden increases in crack growth rate are caused by the wedging action of corrosion products, formed at the crack tip, increasing the crack tip stress intensity.

Of the six WDCP formulations tested Amlguard and Boeshield T9 appeared to be the most effective stress-corrosion inhibitors. All of the WDCP's tested except Amlguard leave oily or, in the case of Boeshield T9, a grease-like film on the surface to which they have been applied. These tacky surfaces are likely to accumulate dust, grit, and fluff which make inspections difficult. Amlguard leaves a hard dry-to-touch film.

4. CONCLUSIONS

(i) WDCP formulations have an inhibiting effect on stress-corrosion cracking in 7075–T651 aluminium alloy under laboratory test conditions.

(ii) The corrosion-inhibiting properties of WDCP formulations are due to the deposition of an impervious moisture barrier on the surfaces being protected. These barriers may be oily, grease-like, or 'dry-to-touch' films. The latter type is to be preferred.

REFERENCES

(1)	F. G. Lewis and B. R. W. Hinton	The effectiveness of the inhibited water displacing fluids LPS-3, PX112, and WD-40 in controlling corrosion, and in slowing the rate of stress corrosion crack propagation. Department of Defence ARL Mat Note 116 Oct. 1976.
(2)	L. Wilson, and R. S. G. Devereux	To be published.
(3)	M. V. Hyatt	Use of precracked specimens in stress-corrosion testing of high strength aluminium alloys. Corrosion—NACE Vol. 26, 487, 1970.

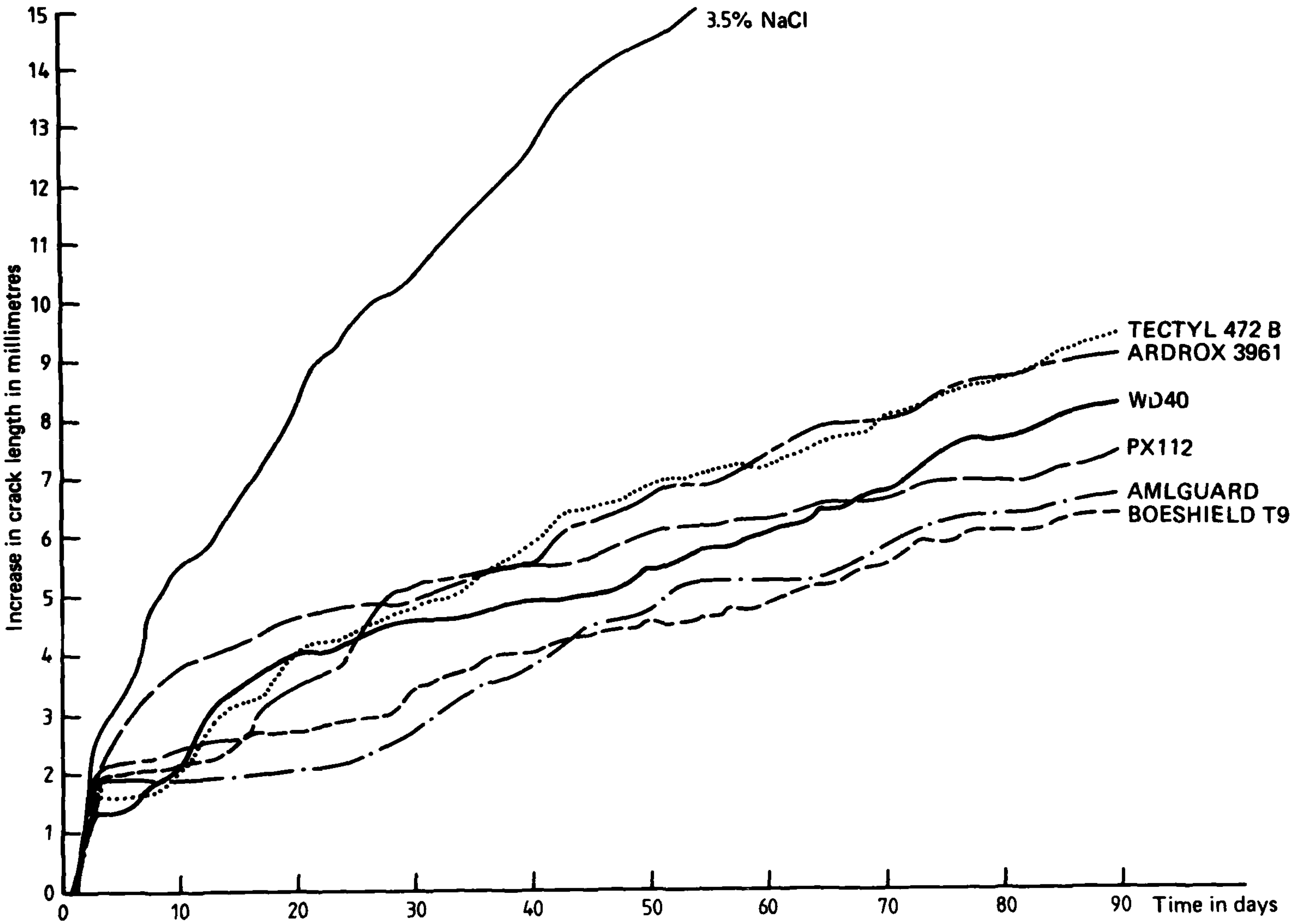


FIG. 1 THE VARIATION OF CRACK LENGTH WITH TIME FOR ALUMINIUM ALLOY 7075 – T651 SPECIMENS TREATED WITH VARIOUS WDCP'S

DISTRIBUTION

AUSTRALIA

Department of Defence

Central Office

Chief Defence Scientist	1 copy	)
Deputy Chief Defence Scientist		)
Superintendent, Science and Technology Programmes		)
Controller, Projects and Analytical Studies		)

Defence Science Representative (U.K.) (Doc. Data sheet only)
Counsellor, Defence Science (U.S.A.) (Doc. Data sheet only)
Defence Central Library
Document Exchange Centre, D.I.S.B. (17 copies)
Joint Intelligence Organisation
Librarian H Block, Victoria Barracks, Melbourne
Director General—Army Development (NSO) (4 copies)

Aeronautical Research Laboratories
Chief Superintendent
Library
Superintendent—Materials
Divisional File—Materials
Authors: L. Wilson
R. S. G. Devereux

Materials Research Laboratories
Chief Superintendent/Library

Defence Research Centre
Library

Navy Office
Navy Scientific Adviser
Directorate of Naval Aircraft Engineering
Superintendent, Aircraft Maintenance and Repair

Army Office
Army Scientific Adviser
Engineering Development Establishment, Library

Air Force Office
Aircraft Research and Development Unit,
Scientific Flight Group
Library

Air Force Scientific Adviser
Technical Division Library
HQ Support Command [SENGSO]

Department of Industry and Commerce

Government Aircraft Factories
Manager
Library

Transport Australia

Library
Flying Operations and Airworthiness Division

Statutory and State Authorities and Industry

CSIRO
Materials Science Division, Library
Trans-Australia Airlines, Library
Ansett Airlines of Australia, Library
Commonwealth Aircraft Corporation, Library
Hawker de Havilland Aust. Pty Ltd, Bankstown, Library

FRANCE

ONERA, Library

INDIA

CAARC Coordinator Materials
Defence Ministry, Aero Development Establishment, Library
Hindustan Aeronautics Ltd, Library
National Aeronautical Laboratory, Information Centre

International Committee on Aeronautical Fatigue
Per Australian ICAF Representative (23 copies)

ISRAEL

Technion-Israel Institute of Technology, Professor J. Singer

JAPAN

National Research Institute for Metals, Fatigue Testing Division
Institute of Space and Astronautical Science, Library

NETHERLANDS

National Aerospace Laboratory [NLR], Library

NEW ZEALAND

Defence Scientific Establishment, Library

SWEDEN

Swedish National Defence Research Institute (FOA)

SWITZERLAND

Armament Technology and Procurement Group
F + W (Swiss Federal Aircraft Factory)

UNITED KINGDOM

Ministry of Defence, Research, Materials and Collaboration
CAARC, Secretary (NPL)
Royal Aircraft Establishment:
Bedford, Library
Farnborough, Dr G. Wood, Materials Department
National Physical Laboratory, Library
British Library, Lending Division

British Aerospace
Hatfield-Chester Division, Library
British Hovercraft Corporation Ltd, Library

UNITED STATES OF AMERICA

NASA Scientific and Technical Information Facility
Metals Information
The John Crerar Library
The Chemical Abstracts Service
Allis Chalmers Corporation, Library
Boeing Co., Mr J. C. McMillan
Lockheed-California Company
Lockheed Georgia
McDonnell Aircraft Company, Library
Metals Abstracts, Editor

Spares (10 copies)

TOTAL, 118 copies

DOCUMENT CONTROL DATA

1. a. AR No AR-002-341	1. b. Establishment No ARL-MAT-NOTE-132	2. Document Date March, 1982	3. Task No DST 80 193
4. Title THE EFFECT OF WATER DISPLACING CORROSION PREVENTIVES ON STRESS CORROSION CRACKING OF ALUMINIUM ALLOY 7075-T651		5. Security a. document Unclassified b. title c. abstract U U	6. No Pages 4 7. No Refs 3
8. Author(s) L. Wilson R. S. G. Devereux		9. Downgrading Instructions —	
10. Corporate Author and Address Aeronautical Research Laboratories G.P.O. Box 4331, Melbourne Vic. 3001		11. Authority (*as appropriate*) a. Sponsor b. Security c. Downgrading d. Approval a) DSTO	

12. Secondary Distribution (*of this document*)
Approved for public release
Overseas enquirers outside stated limitations should be referred through ASDIS, Defence Information Services Branch, Department of Defence, Campbell Park, CANBERRA ACT 2601

13. a. This document may be ANNOUNCED in catalogues and awareness services available to . . .
No limitations

13. b. Citation for other purposes (*ie casual announcement*) may be unrestricted

14. Descriptors		15. COSATI Group
Corrosion prevention	Corrosion fatigue	1103
Corrosion inhibitors	Waterproof coatings	1113
Stress corrosion resistance	Water displacing fluids	
Protective coatings	Water repellants	

16. *ABSTRACT*

The effectiveness of some commercial water-displacing corrosion-preventive formulations with respect to the inhibition of stress-corrosion cracking of 7075-T651 aluminium alloy has been investigated. The formulations consisted of examples of three types of protective agents, viz. oily films, soft (grease-like) films, and hard (resin-like) films. All three types of formulation used were effective in reducing rates of stress-corrosion crack growth in laboratory tests.

17. Imprint
Aeronautical Research Laboratories, Melbourne

18. Document Series and Number	19. Cost Code	20. Type of Report and Period Covered
Materials Note 132	33 1690	—

21. Computer Programs Used
—

22. Establishment File (Ref(s)
—

DATE
ILME